Guadalupe Mountains

Lesson Plans

- Use with the Guadalupe Mountains module.
- Use with the Guadalupe worksheets.
- Appropriate for grades 9 and higher.

Table of Contents

The Big Idea (or Central Theme)

What is the overall concept that we would like students to understand after exploring this module?

- One way living things have played a dramatic role in the earth system is by producing some types of rocks.
- Fossils provide important evidence of how life and environmental conditions have changed.
- Landforms are the result of a combination of constructive and destructive forces.
- Scientific explanations emphasize evidence, have logically consistent arguments and use scientific principles, models and theories.

Essential Questions

What questions will encourage student inquiry?

1. What can a fossilized reef tell you about the Earth's past?

2. How has water affected the landscape of the Guadalupe Mountains?

3. Besides satisfying a desire to understand the past, can you think of an economically important reason to study geology?

4. What if important geological sites like Guadalupe Mountains National Park were not accessible by researchers and the public?

Assessment

What evidence is there that students have achieved understanding of the Big Idea?

Performance Tasks & Projects
Students will create a display on what they learned from their participation in a virtual geological research team which gathered evidence from aerial and landscape views, a virtual hike on the Permian Reef Trail and/or the study of fossils in the field and laboratory.

Through observation, teachers will determine student participation.

Study Questions & Worksheets
Students will complete an exercise on geological principles used in determining the relative ages of strata and the sequence of events affecting them.

Students will answer study questions that can be used to guide their reading of material on the website and assess their comprehension.

Planning Lessons

Lesson One: Piecing Together an Earth Puzzle
Lesson Two: Determining Relative Ages

Piecing Together An Earth Puzzle

Objectives
Students **W**ill **B**e **A**ble **T**o (SWBAT)

- collect evidence of the Guadalupe Mountains' geologic past.
- analyze data gathered from different areas to gain an understanding of the geology of the Guadalupe Mountains.
- make inferences on the implications of specific data.
- work cooperatively in small and large groups.

Inquiry Questions
1. How has our understanding of the Earth's history changed over time?

2. What would fossils of marine organisms found in the desert tell you?

3. How can studying the geologic past be useful for today?

Materials
Computer with internet access
Map of the United States
Posterboard
8.5 x 11 Paper
Scissors
Glue or Tape
Markers

Additional Resources
Consider using fossil collections, information gathered from your travels or study and personal experiences.

Procedure
1. Introduce students to the idea of making a virtual fieldtrip to Guadalupe Mountains National Park. Show them where the park is on a map of the United States. The purpose of the visit will be to learn the geological story of one of the world's best fossilized reefs and apply prior Earth Science knowledge to a specific locale.
2. Allow the students some time to watch the introductory video and read the Introduction to Park Geology and Exposures sections.
3. Assign students to one of three teams that will use the website and study questions to learn about the formation of the Guadalupe Mountains. The levels of focus of the various teams will range from large-scale features that can be assessed from aerial surveys, driving down the highway as well as from hiking in the park to examining rocks up close in the field and fossil specimens both in their natural setting and extracted from the rocks they were found in. The teacher can present the idea that geology has a number of major branches or areas of study and that while geologists have knowledge in many areas, they often specialize in one specific area. These areas of study can then be introduced. The ones relevant for this lesson include geomorphology (the study of landforms and their relationships to underlying structures), biostratigraphy (the study and differentiation of layers of rock based on the fossils they contain and their modes of origin and geologic history) and paleontology (the study of life in past geologic time based on fossil plants and animals).

4. The three teams are ...

   Team One: Geomorphologists

   The students in this team should read the Points of Interest section of the website. Their level of focus will be on large-scale phenomena that can be seen from a distance. They will create a display on posterboard using print-screen images from the website and drawings plus facts gathered through their research to present what these large-scale structures can tell us about the geologic past. Possible structures to consider include the following: dunes, alluvial fans, erosional remnants such as hills and cliffs, water sources and faults. At the the bottom of the poster, students should create two questions they want students from the other teams to answer. This will encourage interactivity when the three teams review each others displays.

   Team Two: Biostratigraphers

   The students in this team should read the Permian Reef Trail section of the website. By making a virtual hike up this trail, they will examine rocks in the field for clues to the geologic past. Along the trail they will find evidence that parts of the reef had been transported from their point of origin in a variety of ways. This team will create a display using print-screen images from the website and drawings plus facts gathered through their research to present evidence that a variety of forces have affected the reef and where this evidence can be found. At the bottom of the poster they are to create two questions they want students from other teams to answer.

   Team Three: Paleontologists

   The students in this team should read the Fossils section of the website. They will gather information on the variety of lifeforms that have been preserved in the rocks of the Guadalupe Mountains. This team will create a display using print-screen images and drawings from the website to show the other students examples of the major reef builders and at least one example of a lifeform that lived in the shallow lagoon behind the reef and an example of a creature that lived on the seafloor. At the bottom of the poster they are to create two questions that they want the other students to answer.

5. Allow students time to look at the other teams' displays. As the students review the other students' displays, encourage them to interact with members of their team as well scientists from the other teams when trying to answer the questions being posed to them.

Discussion Questions

1. Is science only a collection of random facts?

2. Can you think of rival interpretations for the formation of the Guadalupe Mountains? Can these interpretations be tested based on observation and measurement? If not, can they be considered scientific?

3. Why do you think some of the statements in today's lesson use terms like "may" and "possibly?"

4. How could fossil collecting by amateurs and commercial interests affect our understanding of geology?

Assessment

Students **W**ill Be **A**ssessed **O**n...

1. Participation in classroom discussion and other activities.

2. Completed display and study questions.

Differentiation

To best meet all students' needs, we suggest...

1. If the displays and study questions are completed in groups, use heterogeneous grouping so that more advanced students can be of help to their teammates.

2. Visual learners will gain a better understanding by diagramming the processes that have affected the terrain. Some of their diagrams can be used for the display. Auditory learners may need help with pronunciation. Kinesthetic learners might create three-dimensional models from paper of the reef and attach to the display with glue.

3. Students requiring extra guidance might be assigned a defined role for their team. One may be in charge of drawings, another of making labels, and one with the overall layout or placement of images and text.

Study Questions

Introduction to Park Geology & Exposures

1. How was the Capitan Reef community different from modern day reefs?
2. Why can reef debris be found on deposits formed on the seafloor?
3. How was the Earth's surface different during the Permian Period than to today?
4. What caused the Delaware Basin's water to disappear?
5. What kind of sediments filled the Delaware Basin and buried the reef?
6. How could a significant cooling or warming of the Earth's climate have affected the Delaware Basin?

Permian Reef Trail

7. How was the climate different during the Pleistocene Epoch?
8. What forces created the conglomerates formed on the Permian Reef Trail?
9. At Stop 1 Pleistocene conglomerates and alluvium lay on Permian aged rocks. Why do you think there are no rocks from the intervening geologic periods?
10. Where did fusulinids live relative to the reef?
11. How is a trace fossil different from most other fossils?
12. Why were sponges not restricted to specific life zones on the reef?
13. What kind of forces formed the large calcite crystals found on the Permian Reef Trail?
14. What kind of clues can you find on the Permian Reef Trail that indicate sea levels dropped at some time in the reef's history?
15. How did portions of the reef and lagoon become dolomitized?
16. How could you determine whether the Capitan Reef was a continuous structure and not dissected by McKittrick Canyon during the Permian?

Points of Interest

17. What happened in 1931 that may have caused the failure of Pine Springs?
18. What type of sand are the white dunes in the Salt Basin composed of?
19. What did the continental shelf look like before the formation of the reef?
20. What kind of deposit can be found on the very top of Guadalupe Peak?
21. Why are there springs in the foothills of the eastern escarpment and not in the higher elevations of Guadalupe Mountains National Park?
22. Why is the altered ash layer found in Nipple Hill significant?
23. Would geologists be able to establish an absolute date without this ash layer? Why or why not?

Fossils

24. What type of organisms bound and cemented the loose materials of the reef?
25. Spiral-shaped fossils consisting of numerous chambers belonged to which creature?
26. Spiral-shaped fossils that lack cross-cutting segments or chambers belonged to which creature?
27. What instrument would a scientist use to identify types of conodonts?
28. Which event in the Earth's history greatly reduced the variety of sponges?
29. How did horn corals differ from modern day corals?
30. Why do you think relatively few fish fossils have been found in the Guadalupe Mountains?
31. How does past climate change compare with that of today?
32. Explain how water has affected the landscape of the Guadalupe Mountains.

Determining Relative Ages

Objectives
Students **W**ill **B**e **A**ble **T**o (SWBAT)

- analyze complex geological phenomena.
- apply principles used in geological research.
- organize observations into a sequence of events and determine the relative age of rock layers and events.

Inquiry Questions
1. Without being able to go back in time, how can geologists determine the relative age of rock layers and events?

2. Imagine you discovered a number of animal tracks crossing one another. How might you start trying to determine who crossed the area first?

Materials
Worksheets on Law of Superposition
pens or pencils

Procedure
1. Present the background information on the laws of superposition, original horizontality, cross-cutting relationships and inclusion.
2. Discuss the examples given.
3. Allow students time to do the exercises on the worksheet.

Discussion Questions
1. Can you think of any other sciences that use the law of superposition?

2. Can you think of an instance where a structure included within another is younger and not older?

Exercises

Geologists have a toolbox of interpretive principles that help them explain the forces that have shaped the land. They are based on observation, geometry and common sense. The following principles were summarized by Charles Lyell in his 1832 textbook "Principles of Geology." You will use these principles to determine the relative age of rock layers and the sequence of events that affected them.

The principle of superposition—in a vertical sequence of sedimentary or volcanic rocks, a higher rock unit is younger than a lower one.

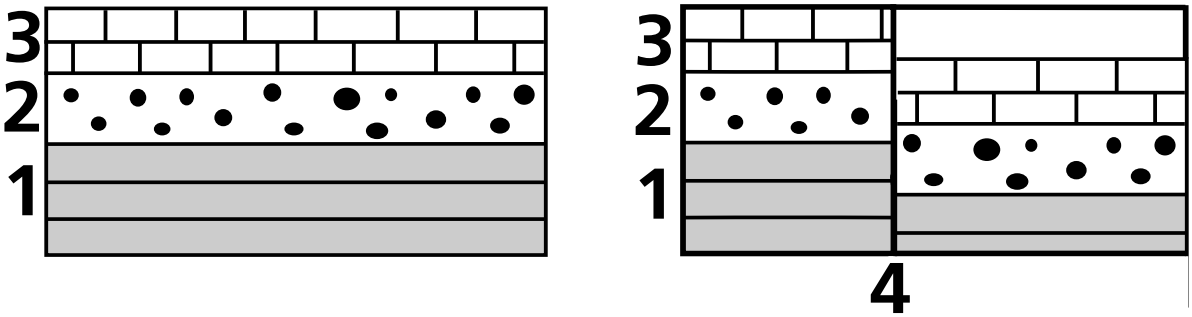
The principle of original horizontality—rock layers were originally deposited close to horizontal.

The principle of cross-cutting relationships—a structure that cuts another is younger than the structure that is cut.

The principle of inclusion—a structure that is included in another is older than the including structure.

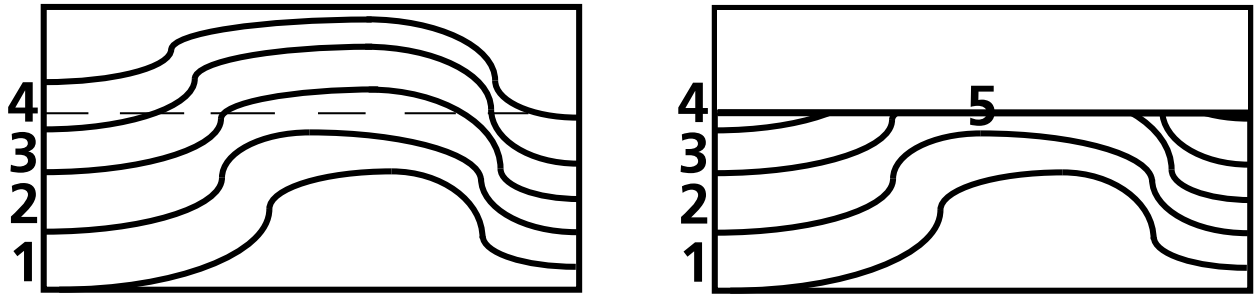
Can you think of any exceptions to these principles? There are a few cases, but these principles are generally true and can be empirically tested if needed.

Putting Theory Into Practice

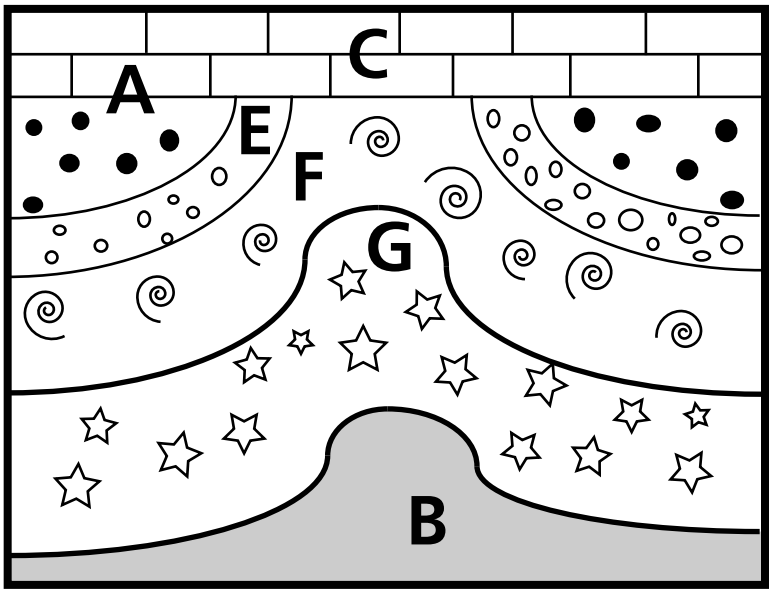


Above: The diagram on the left shows a sequence of strata. The bottom-most layers (1) are the oldest, followed by the middle layer (2) and the top layers (3) are the youngest. At the right a fault (4) has fractured the strata and moved their positions relative to one another.

Below: The diagrams on the left shows four layers of sedimentary rock (1-4) that have been folded by tectonic forces. In the diagram at the right, erosion (5) has removed some portions of the top layers.



Apply your knowledge of the laws of superposition, original horizontality, cross-cutting relationships, and inclusion to interpret the sequence of events in the following diagrams.



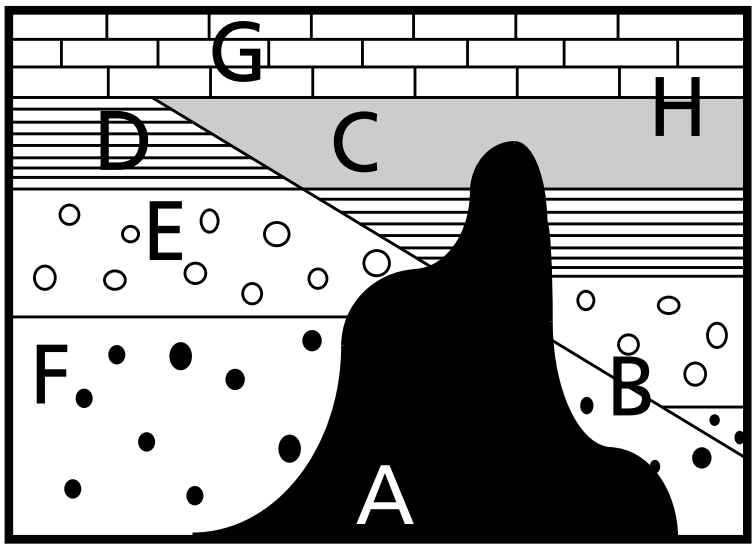
What is the correct sequence of events?

Which layer is the oldest?

Which layer is the youngest?

What happened to layers B,G,F and E?

What happened at A?



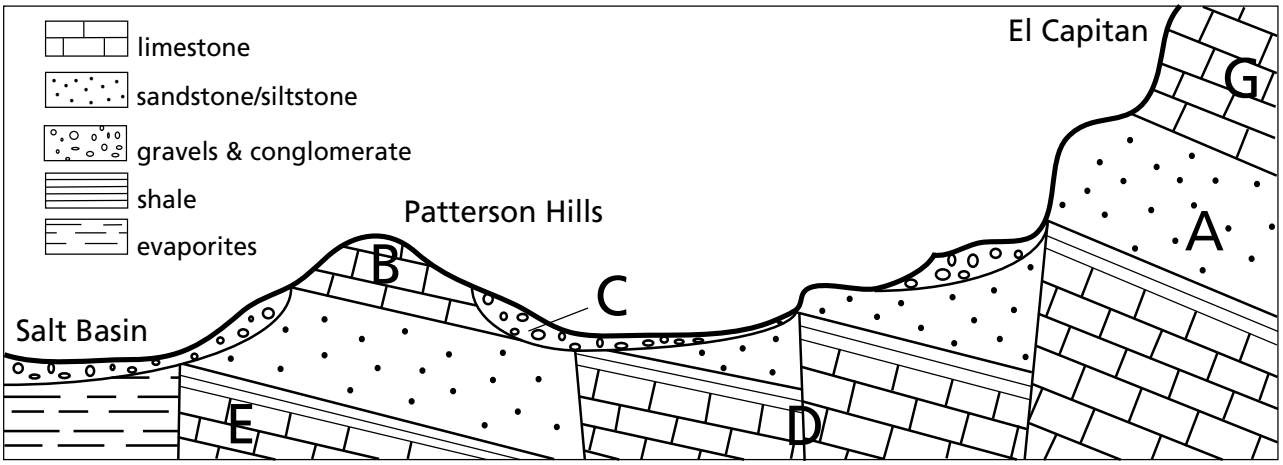
What is the correct sequence of events?

Which layer is the oldest?

Is it possible to determine whether A is older than G?

Is the igneous intrusion (A) older than the fault (B)?

Where do you think the other half of layer C is?



What is the correct sequence of events?

Which layer is the oldest?

Which layer is the youngest?

Which two layers are equivalent in age?

Can you determine the relative age of the evaporites?

For further thought

Can you think of any sciences other than geology that use the law of superposition?

Imagine you are writing a detective story and need to create a crime scene. Describe the scene and provide clues based on the law of superposition. See if your friends can guess what happened.